Claims

1. A microcapsule comprising:

a permeable polymer membrane comprising a plurality of cinnamoyl groups, the cinnamoyl groups being capable of forming cross-links upon exposure to radiation; and

a bioactive substance encapsulated by the permeable membrane.

2. A microcapsule as claimed in claim 1, wherein a monomer group has the cinnamoyl groups incorporated into a polymer backbone of the polymer membrane.

3. A microcapsule as claimed in claim 1, wherein the permeable polymer membrane comprises:

an inner polymer layer comprising a first polymer; and

an outer polymer layer comprising a second polymer.

4. A microcapsule as claimed in claim 3, wherein the first polymer has a first electrical charge and the second polymer has a second electrical charge opposite to the first electrical charge.

5. A microcapsule as claimed in claim 3, wherein the outer polymer layer comprises a copolymer that comprises the plurality of cinnamoyl groups.

6. A microcapsule as claimed in claim 3, wherein the permeable polymer membrane is selectively permeable and the outer polymer layer comprises at least one hydrophobic group and at least one hydrophilic group for controlling the selectivity of the membrane.

7. A microcapsule as claimed in claim 6, wherein the at least one hydrophobic group of the outer polymer layer is adjacent to the inner polymer layer and the outer polymer at least partially surrounds the inner polymer layer.

8. A microcapsule as claimed in claim 3, wherein the second polymer is an anionic tetra-copolymer comprising groups derived from hydroxyethyl methacrylate, methyl methacrylate, methacrylic acid and methoxycinnamoyl phenyl methacrylate.

9. A microcapsule as claimed in claim 3, wherein the first polymer is a cationic biopolymer comprising collagen modified to have a pKI of at least about 9.

10. A microcapsule as claimed in claim 1, wherein the bioactive substance is suspended within a cationic biopolymer comprising collagen modified to have a pKI of at least about 9.

11. A microcapsule as claimed in claim 1, wherein the bioactive substance comprises cells and the permeable polymer membrane is a selectively permeable membrane that is permeable to one or more materials necessary to sustain the normal metabolic functions of cells and to products released by the cells and impermeable to one or more immune system components associated with immune rejection in an animal.

12. A microcapsule as claimed in claim 1, wherein the bioactive substance comprises living cells or genetically engineered cells selected from the group consisting of: hepatocyte cells, hematopoietic cells, epithelial cells, secretory cells, ciliated cells, contractile cells,

sensory cells and neuronal cells and one or more combinations thereof.

13. A microcapsule as claimed in claim 1, wherein the bioactive substance is selected from the group consisting of: therapeutic compounds, neurological compounds, vitamins, vitamin derivatives, growth factors, glucocorticosteroids, steroids, antibiotics, anti-bacterial compounds comprising bacteriocidal and bacteriostatic compounds, anti-viral compounds, anti-fungal compounds, anti-parasitic compounds, tumoricidal compounds, tumoristatic compounds, toxins, enzymes, enzyme inhibitor proteins, peptides, minerals, neurotransmitters, lipoproteins, glycoproteins, immunomodulators, immunoglobulins and corresponding fragments, dyes, radiolabels, radiopaque compounds, fluorescent compounds, fatty acid derivatives, polysaccharides, cell receptor binding molecules, anti-inflammatory compounds, anti-glaucomic compounds, mydriatic compounds, anesthetic compounds, nucleic acids, polynucleotides and combinations of one ore more thereof.

14. A microcapsule as claimed in claim 1, wherein the molar concentration of cinnamoyl groups provided in the permeable polymer membrane is in the range between about 0.01 mol% to about 4 mol%.

15. A microcapsule as claimed in claim 1, wherein the outside diameter of the microcapsule is between about 500μm to about 1,500μm.

16. A microcapsule as claimed in claim 1, wherein the cinnamoyl groups are derived from a monomer selected from the group consisting of: 4-(4-Methoxycinnamoyl)phenyl

methacrylate; 3,4-dimethoxycinnamoyloxyethyl methacrylate, 3,4,5-trimethoxycinnamoyloxyethyl methacrylate, cinnamoyloxyethyl methacrylate and one or more combinations thereof.

17. A microcapsule comprising:

a permeable polymer membrane comprising at least one crosslinking group derived from at least two cinnamoyl groups; and

a bioactive substance encapsulated by the permeable polymer membrane.

18. A microcapsule comprising:

a permeable polymer membrane comprising:

an inner polymer layer comprising a first polymer having a first electrical charge;

an outer polymer layer comprising a second polymer having a second electrical charge opposite to the first electrical charge, the second electrical charge being sufficient to form a complex with the first polymer of the inner polymer layer;

a plurality of monomer groups comprising cinnamoyl groups incorporated into a backbone of the first polymer or the second polymer, the cinnamoyl groups being capable of forming cross-links when exposed to light at a wavelength in the range from 340 nm to 700 nm; and

a bioactive substance encapsulated by the permeable membrane.

19. A method of preparing a microcapsule, comprising the steps of:

(a) providing a first solution of a first polymer;

(b) providing a second solution of a second polymer;

(c) providing a bioactive substance in the first or the second polymers; and

(d) introducing the first solution, the second solution and the bioactive substance to form a permeable polymer membrane at least partially surrounding the bioactive substance;

wherein at least one of the first polymer and the second polymer has a plurality of cinnamoyl groups capable of forming cross-links upon exposure to radiation.

20. A method according to claim 19 comprising the additional step of exposing the permeable polymer membrane to radiation so that the cinnamoyl groups form cross-links within the permeable polymer membrane.

21. A pharmaceutical composition comprising a pharmacologically effective plurality of the microcapsules of claim 1, together with a pharmacologically acceptable carrier.

22. Use of one or more microcapsules as claimed in claim 1, in a liver assist device.

23. Use of one or more microcapsules as claimed in claim 1, as a stem cell scaffold material.

24. Use of one or more microcapsules as claimed in claim 1, in the controlled delivery of therapeutic agents.